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Selection of Microfungi by Enchytraeidae (Oligochaeta) and other members of the soil fauna

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With 2 figures

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1. Introduction

A knowledge of the food requirements of members of the soil fauna is essential if we are to understand the processes occurring in the decomposer component of terrestrial ecosystem. In many habitats, e.g. tundra, moorland, coniferous forest, the Enchytraeidae form a large percentage of the microfaunal biomass and the present study was designed to determine whether the organisms feed on fungi and to what extent, if any, they actually select certain types of fungi. In testing food selection by enchytraeids some information has been obtained on preferences shown by Collembola and Acarina.

In the present investigations three techniques, fungal baits, squash preparations and the culturing of gut contents have been used to investigate food selection by Enchytraeidae occurring in aspen woodland soil in the Kananaskis valley, Alberta, Canada. The taxonomy of the Enchytraeidae of that region has been described by DASH (1970) and the general ecology of the group by DASH and CRAGG (1972).

2. Methods

2.1 Fungal baits

Four fungal species occurring in the L, F and H layers of the soil profile in the aspen woodland were obtained from the late Mr. G. C. BHATT and Dr. PAUL WIDDEN. They were sub-cultured at intervals on Czapek-Dox agar. The species were: an undescribed species of the Sphaeropsidales (*Ceuthospora* sp.), *Cladosporium* sp., *Penicillium* sp., and *Paecilomyces* sp. Blocks approximately 3 × 3 cm were cut from the culture, wrapped in a coarse mesh cloth and at intervals placed at a depth 2—4 cm (below the L layer) in the experimental site. Sterile Czapek-Dox were used as controls and nutrient agar blocks were also tested as baits.

Ten to sixteen blocks of each type of fungal bait were collected at seven day intervals during the summer months of 1968 and 1969. After collection, each bait was examined under a microscope for members of the soil fauna with the exception of Protozoa. Each 3 × 3 cm block was used only once. The total catch was preserved in 70% ethanol containing glycerine.

2.2. Squash preparations

Forty-two enchytraeids collected from fungal baits were prepared as squashes and their gut contents analysed for portions of fungal mycelia, plant material and mineral particles. The method described by O'CONNOR (1967) for obtaining a relative measure of abundance was used. The materials were spread out on a slide and the grid (1 cm²) was put inside the ocular tube and the number of squares which contained each type of material were counted. The number and species

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of enchytraeids examined were 8 *Henlea nasuta*, 13 *Henlea perpusilla*, 13 *Marionina canadensis*, 5 *Enchytraeus buchholzi*, 3 *Marionina craggi*.

These results have been compared with similar observations made on the gut contents of 80 enchytraeids (20 *Henlea nasuta*, 20 *Henlea perpusilla*, 20 *Marionina canadensis*, 10 *Enchytraeus buchholzi*, 10 *Marionina craggi*), extracted from soil samples which were collected from the aspen site.

2.3. Culturing of gut contents

Enchytraeids collected from soil samples and washed thoroughly in distilled water were examined for the presence of fungi. Ten individuals containing fungal material were each cut into two parts (preclitellar and postclitellar). The two parts of each individual were squashed separately on sterilised slides and transferred either to Czapek-Dox agar or oatmeal agar media. The aim was to determine whether the fungal material present in the gut was viable or not and which part of the gut contained viable fungi.

3. Results

3.1. Collection from fungal baits

The abundance of occurrence of different members of the soil fauna found on the baits is given in Table 1. Approximately 3000 animals comprising Collembola, Acarina, Nematoda, Enchytraeidae and Insect larvae were collected from 500 fungal baits during the summer months of 1968 and 1969. Of the total animals, 47% were collected from the *Ceuthospora* sp., 37% from *Cladosporium* sp., 8% from *Penicillium* sp., and another 8% from *Pae-
cilomyces* sp.

Table 1 Abundance of occurrence of soil fauna in fungal baits

	<i>Ceutho- spora</i> sp.	<i>Clado- sporium</i> sp.	Bait <i>Peni- cillium</i> sp.	<i>Paccilo- myces</i> sp.	C-D Agar Control	N-Agar	Total no. of animals collected
Enchytraeidae	40	51	4	1	0	1	97
Collembola	496	284	113	80	7	0	980
Acarina	389	239	87	75	10	0	800
Nematoda	258	227	35	39	1	51	611
Insect Larvae	136	251	14	15	0	0	416
Total	1319	1052	253	210	18	52	2904

Of the total enchytraeids, some 53% were collected from *Cladosporium* sp., 42% from the *Ceuthospora* sp., 4% from *Penicillium* sp., and 1% from *Pae-
cilomyces* sp. Relatively few animals were found on the Czapek-Dox agar controls. Nutrient agar attracted a large number of nematodes and in some cases bacterial colonies became established on these blocks and only one enchytraeid was observed on them.

3.2. Gut content analysis

Figures 1 and 2 show percent composition of the gut contents of enchytraeids collected from soil samples and from fungal baits respectively. Analyses of the gut contents of enchytraeids collected from soil samples indicated that species of *Henlea*, *Enchytraeus* and *Marionina* ingested large amounts of organic matter and mineral particles rich in fungi.

The gut contents of individuals collected from fungal baits showed the presence of a high percentage of fungi with mineral particles and plant materials. Fungal material constituted some 50—55% of the gut contents of *Henlea* sp., 55—75% in *Marionina* sp., 47% in *Enchytraeus buchholzi*.

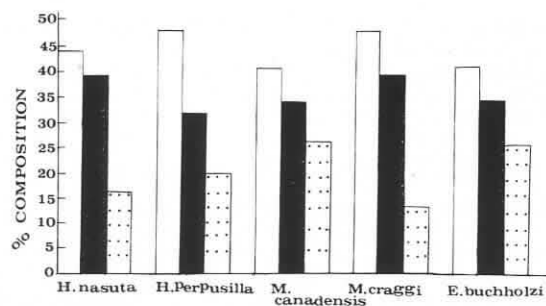


Figure 1. Percent composition of the gut contents of enchytraeids collected from soil samples, Organic matter; fungi; mineral particles.

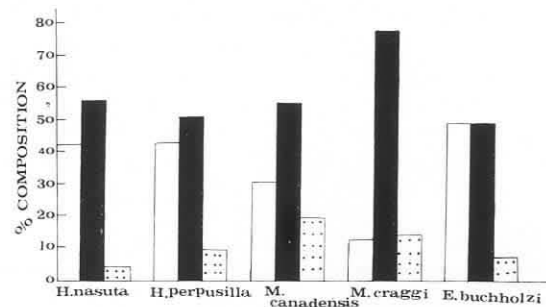


Figure 2. Percent composition of the gut contents of enchytraeids collected from fungal baits. organic matter; fungi; mineral particles.

3.3. Culture of gut contents

Fungal colonies occurred in only two out of ten cultures made from the contents of the preclitellar portions of the gut. The colonies were a *Penicillium* sp., which differed from the one used in the fungal baits and a colony of the *Cladosporium* sp. used in the baits. Inoculations made from the postclitellar portion did not give rise to fungal colonies but produced Actinomycetes.

4. Discussion

O'CONNOR (1967) studied squash preparations of three species of enchytraeids from a Douglas fir site in North Wales. His results indicated that *Achaeta eiseni* and *Cognettia cognetti* consumed twice the amount of fungus that would have been expected if they had fed on their surrounding substrate in a random manner. Furthermore, *Achaeta* had less plant material in its gut than would have been expected, and that *Cognettia* had less mineral material. The third species, *Marionina cambrensis*, did not show any degree of selectivity of any of the materials.

The present investigation reinforces the observations made by O'CONNOR. It is clear that selectivity of fungal material is shown by enchytraeids and furthermore that they can select between species of fungi. SPRINGETT (pers. communication, 1967) has reported that *Cognettia sphagnetorum* will grow on a sterile dark fungus and that age of the mycelium influences the growth of the species, the best growth occurred in young cultures.

To what extent bacteria are utilised as food is not certain. DOUGHERTY and SOLBERG (1960, 1961) have veared *Enchytraeus fragmentosus* in monaxenic culture of *E. coli* on

agar slants and in axenic cultures of agar supplemented with heated lamb liver extract.

Nematodes have been recorded in the gut of enchytraeids by us. Normally two or three occurred in the gut but as many as 18 have been recorded in the gut of one individual. Nematodes were observed alive in the gut but in most cases the outline of the animal was diffused. Nematode parasites were also recorded in the coelom of a small percentage of enchytraeids. Presence of nematodes in the gut of enchytraeids can be looked upon as a chance occurrence and not as an important source of food.

The results in Table 1 indicate that the selection of *Ceuthospora* sp. and *Cladosporium* sp. was not confined to the enchytraeids since large numbers of other members of the soil fauna were also associated with these two species.

5. Acknowledgements

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6. Summary · Zusammenfassung

The food preferences of four species of Enchytraeidae have been examined by three techniques: 1. fungal baits; 2. squash preparations of the gut; 3. culturing the gut contents.

Four fungal species common in forest soils of the Kananaskis region were tested as baits for the soil fauna. About 3000 animals comprising collembola, mites, insect larvae, nematodes and enchytraeids were collected from 500 baits.

About 47% of the total catch occurred on *Ceuthospora* baits, 37% on *Cladosporium* sp., 8% on *Penicillium* sp., and 8% on *Paecilomyces* sp. Of the total Enchytraeidae, 53% were on *Cladosporium* baits, 42% on *Ceuthospora*, 4% on *Penicillium* and 1% on *Paecilomyces*.

Analysis of gut contents of enchytraeids showed them to have a high content of fungal material in the preclitellar portions. Isolation experiments produced on *Penicillium* sp. (different from the one used as bait) and the *Cladosporium* sp. from the preclitellar portions of the gut of enchytraeids extracted from soil samples. Isolations made from postclitellar gut content did not give rise to fungal colonies but produced Actinomycetes.

Ingested nematodes have been recorded in the gut of enchytraeids and nematode parasites have been recorded in the coelom of enchytraeids.

Die Nahrungspreferenz von vier Enchytraeiden-Arten wurde mit Hilfe von 3 Techniken untersucht: 1. durch Pilzköder; 2. durch Quetschpräparate des Verdauungstraktes; 3. durch Kultur von Mikroorganismen aus dem Inhalt des Verdauungstraktes.

Vier im Waldboden der Kananaskis-Region gewöhnlich vorkommende Pilzarten wurden als Köder für die Bodenfauna getestet. Etwa 3000 Tiere, einschließlich Collembolen, Milben, Insektenlarven, Nematoden und Enchytraeiden, wurden von 500 Ködern gesammelt. Rund 47% der Gesamtbeute fand sich auf *Ceuthospora* spec., 37% auf *Cladosporium* spec., 8% auf *Paecilomyces* spec. Von den gesamten Enchytraeiden fanden sich 53% auf *Cladosporium*-Ködern, 42% auf *Ceuthospora*-, 4% auf *Penicillium*- und 1% auf *Paecilomyces*-Ködern.

Analysen des Inhaltes vom Verdauungstrakt von Enchytraeiden zeigten, daß sie im präclitellaren Abschnitt viel pilzliches Material enthalten. Isolierungsversuche aus dem Inhalt des präclitellaren Abschnittes des Verdauungstraktes (von aus dem Boden ausgelesenen Enchytraeiden) erbrachten den Nachweis einer *Penicillium*-Art (die von der als Köder benutzten Art verschieden war) und von *Cladosporium* spec. Im postclitellaren Teil des Verdauungstraktes wurden keine Pilze, sondern nur Aktinomyceten gefunden.

Mit der Nahrung aufgenommene Nematoden wurden im Verdauungstrakt, und als Parasiten lebende Nematoden wurden in der Leibeshöhle gefunden.

7. Literature

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